On the Osteology of the Solitaire (*Pezophaps solitaria*, Gmel.).—By Edward Newton, C.M.G., M.A., F.L.S., and John Willis Clark, M.A., Superintendent of the Museum of Zoology and Comparative Anatomy in the University of Cambridge.

(Plates XLIV.–L.)

In the Memoir on the Osteology of the Solitaire in the Philosophical Transactions for 1869, by Messrs. Alfred and Edward Newton, the authors entered fully into the history of the Bird, and recounted the circumstances under which a large collection of its remains had been discovered in the caverns of the island of Rodriguez.

That island having been selected as one of the stations from which the Transit of Venus in 1874 should be observed, it was suggested that a thorough examination of the caves should be instituted in the hope of obtaining those portions of the skeleton which the previous researches had failed to discover. The naturalist appointed to that station, Mr. H. H. Slater, sent home a large series of bones, out of which several male and female skeletons, almost complete, have been sorted. The major part of this collection is now in the British Museum.

Previous to this expedition Mr. Edward Newton had requested Mr. George Jenner, resident magistrate of Rodriguez, who had before been good enough to interest himself in the search, to make a fresh examination of the caves. The result was a large collection of bones, supplementing many deficiencies; but unfortunately, neither in Mr. Slater's collection (when it arrived in England) nor in that of Mr. Jenner were there any remains which could be proved to be associated. Mr. Jenner's collection, found in January and February 1871, has been deposited in the Museum of the University of Cambridge. He accompanied his collection by a most interesting report, in which he described the localities where the bones had been found. This it was our wish to have been allowed to print in connexion with this paper. As, however, Mr. Slater had gone over the same ground, and composed a report of a similar character to that by Mr. Jenner, we were reluctantly compelled to acquiesce in the suppression of the latter.

In the following Paper we have naturally drawn our descriptions mainly from specimens in the collection that was most accessible to us; but the Council of the Royal Society having placed Mr. Slater's collection at our disposal for description, we have availed ourselves of that series of specimens when it appeared to us necessary to do so.

Vertebræ.

In the former Memoir the difficulty of coming to any accurate conclusion respecting the number of vertebræ was felt to be so great that the authors stated that "it is beyond our power to determine precisely the number which the skeleton " contained." The assumption that nineteen vertebræ intervened between the skull and the last dorsal (that which is anchylosed to the pelvis) was made doubtfully, and with the full expectation that more extended study might reverse it. It was based on the probability that *Pezophaps* would possess as many vertebræ as *Didus*, and on the fact that Prof. OWEN's artist had assigned that number to the latter.*

The former collection contained one hundred and sixty-one vertebræ. Those received in the recent collection of Mr. Jenner alone augment this number to three hundred and thirty-two assignable to the cervical region, which we conceive should be distributed as follows :—

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	Total.
♂	2	10	11	12	16	14	13	13	13	14	15	11	10	154
♀	1	12	13	13	17	16	18	22	14	18	12	10	12	178

The penultimate free dorsal, the eighteenth of the series according to our present view, is represented by ten female and eleven male examples. We are, therefore, now enabled to give a complete figure of this vertebra, Plate xliv. figs. 1, 2, of which the former collection possessed only more or less broken examples. The neural spine is developed so as to attain a height equal to that of the three anchylosed vertebræ that precede it, and as in them its summit is marked by a ridge. The other parts of the vertebra were sufficiently described in the former paper (p. 332, Plate xv. figs. 56–59).

The fourteenth vertebra (figured in the former paper, Plate xv. figs. 48–50) has its neural spine prolonged into a thick broad ridge, which does not reach quite so high as the coalesced spines of the three succeeding vertebræ. It sends forwards a long blunted process extending rather beyond the anterior edge of the centrum.

The thirteenth vertebra, Plate xliv. figs. 3, 4, has its neural spine developed in a similar manner to the fourteenth, but not to so great an extent. The walls of the

* Phil. Trans. 1869, p. 332. The number nineteen is not given in the text, but nineteen vertebræ are figured (Plate xv.), and in the "Description of the Plates," p. 359, the words occur, "Twelfth (and last ?) " cervical vertebra," "Penultimate (seventh ?) dorsal vertebra."

neural canal slope inwards, and the roof curves downwards in the centre, so that the outline becomes sub-cordate. The anterior zygapophyses are elliptical, and nearly flat; their surfaces slope inwards and upwards. The posterior are slightly concave and slope upwards and outwards. The transverse processes are broad and flat and inclined downwards and backwards. In some specimens of this vertebra in the collection the canal for the vertebral artery is developed, but in only one instance on both sides. The hypapophysis resembles that of the fourteenth vertebra, but is smaller.

In the twelfth vertebra, Plate xliv. figs. 5, 6, the neural processes have not united into a spine, but are present as two thin plates of bone, including a canal. The transverse processes are extremely wide and strong, and develop broad processes which extend downwards and backwards to meet the process sent up from the anterior edge of the centrum, and so form a large arterial canal.

Ribs.

Six appears to be the normal number of dorsal ribs, though in some examples, as in the large male skeleton, of which the pelvis is here figured, Plate xlvi. fig. 1, a seventh appears.

The first of these articulates with the fourteenth vertebra: the sixth with the nineteenth vertebra, which coalesces with the pelvis. The first and second are without any corresponding sternal ribs, but the third, fourth, fifth, and sixth, had corresponding sternal appendages. The seventh, when present, had a similar appendage, which failed to reach the sternum, but was connected by ligament with the sterno-costal rib immediately preceding. Only three or four examples of these ribs, attached in this manner to each other, have been found, even in the combined collections, and then only on one side or the other. The figure, Plate xlv. fig. 1, from a specimen in the British Museum, represents the structure in a very old individual, where the two sternal ribs have become anchylosed.

In the former paper it was said (p. 334), "There appears to have been eight "pairs of dorsal and four of sternal ribs. The first probably articulated with the "thirteenth vertebra, the last or eighth with the twentieth." This statement we now hold to be partially incorrect.

It was formerly estimated that nineteen vertebræ were interposed between the cranium and the last dorsal vertebra, that which is anchylosed to the pelvis. We now incline to consider that there are eighteen only, of which we assign thirteen to the cervical region, and five to the dorsal; so that there are six dorsal vertebræ in all, for we cannot count as normally dorsal that which we have found in a few examples only, as above stated, with a rib attached to it.

In *Didus* the number of ribs appears to be eight. The first two, as in *Pezophaps*, have no sternal appendages; the next five have sternal appendages

articulating with the sternum, and the last an appendage which fails to reach the sternum, but articulates with the sterno-costal appendage preceding it. This description is derived from a study of Professor OWEN's figure.*

In *Didunculus* there are only six ribs; the first is free; the second has a much attenuated sternal appendage corresponding to it, which articulates with the sternum, but fails to meet the rib by a slight interval; the next three have sternal appendages articulating both to them and to the sternum, and the last has a sternal appendage attached by ligament to the similar appendage of the preceding rib.

In the following Pigeons of which we have been able to examine specimens, the dorsal rib, articulating with and anchylosed to the first pelvic vertebra, has no proper sterno-costal rib, but only an appendage which joins its extremity, and is attached to the sterno-costal rib immediately preceding by ligament. The species are *Phaps chalcoptera*, *Phaps elegans*, *Phlogœnas crinigera*, *Phlogœnas cruentata*, *Carphophaga microcerca*, *Calœnas nicobarica*, *Geotrygon violacea*, *Starnœnas cyanocephala*, *Treron calva*, *Columba œnas*, *Didunculus strigirostris*. In *Goura* and *Pezophaps*, however, this rib has its own sterno-costal rib. Out of all these species *Pezophaps*,† *Phaps chalcoptera*, and *Goura coronata*, alone present any evidence of a rib articulating with the second vertebra of the pelvis.

We figure (Plate xlv. figs. 2–6), the vertebral ribs of the right side of a female skeleton. The uncinate processes are somewhat more slender and recurved than those of *Didus*, but in other respects the ribs bear a close general resemblance to those of that bird. We also figure three of the sternal ribs on the same plate. Of these, the first and second, figs. 7, 8, are of the left side; the third, fig. 9, of the right. The surface articulating with the sternum is marked *a*; that with the rib is marked *b*.

Pelvis.

The present collection formed by Mr. Jenner contains eight examples, three of which were probably males, and five females, in which the sacro-caudal vertebræ are complete. We find the number of these, as stated before, to be eighteen.

The anterior portion of the pelvis was so complete in the former specimens, that any further description is unnecessary. We can now, however, describe and figure the posterior extremities of the ilium, ischium, and pubes, which before were unknown.

The last six sacro-caudal vertebræ are of uniform width. The first three of these are separated from the ilia by a depression on the superior surface in older specimens,

* Transactions of the Zoological Society of London, vol. vi. pl. xv.

† It will be observed that the first pelvic vertebra is the eighteenth of the series in *Goura* and *Phaps elegans*, the nineteenth in *Calœnas nicobarica*, *Phlogœnas cruentata*, *Carpophaga violacea*, *Phaps chalcoptera* and *Pezophaps*, and the twentieth in *Phlogœnas crinigera*.

and by a slight interval in younger ones. The last three are quite free, and the inner edge of the posterior portion of the ilium bends away from them, first outwards, then inwards, then outwards again, and forms a blunted process at the termination of the ridge which separates the ilium from the ischium, Plate xlv. fig. 2.

The extremity of the ischium was figured before, (Plate xviii. fig. 70); and the perfect specimens now before us show that the extremity, as there drawn, was hardly, if at all, broken. The assertion there made (p. 336), as to the "lower margin "sloping downward and outward, as if to pass and avoid the pubic style" is fully borne out by extended observation. In one specimen only, a very large male,* (Plate xlvi. fig. 1) they might possibly have met, as there is a trace of an articular surface on each bone (Plate xlv. fig. 13). The extremity of the pubic bone, perfect in two specimens, a male and a female, would appear to vary considerably (Plate xlv. fig. 13, Plate xlvii. fig. 1).

In the former (the specimen mentioned above) the extremity turns round the posterior process of the ischium, and terminates bluntly at about a quarter of an inch beyond it. In the latter it turns inwards and slightly upwards on reaching the same parts, making a hook-like process about half an inch in length.

The collection contains six caudal vertebræ, including the coccyx. It is of course quite impossible to say to how many individuals these belong. Their most noticeable peculiarity is the feeble development of the neural ridge, as might have been expected from the similar conditions of the sacro-caudal vertebræ, and the extraordinary shape of the coccyx (Plate xlvi. fig. 2.) This bone is nearly rectangular, and tapers very slightly from before backwards. Its length is nearly equal to its height. From its inferior surface it sends forward a small process to pass under the centrum of the preceding vertebra.

The drawing of a restored pelvis (Plate xlvi.) will show how completely the tail must have fallen within a line joining the pelvic bones. This must have been the case in *Didus* also; but in that bird the ilium was suturally connected with the entire series of sacro-caudal vertebræ, so that the caudal alone were free.†

Sternum.

We are now able to figure nearly complete specimens of this bone. In the former paper the anterior portions of the "pleurosteon" were described and figured,‡ but the posterior portion was broken in all the specimens. Immediately behind the articulations for the ribs is a short broad "metosteon," subject to considerable indi-

* This pelvis has been placed on the mounted skeleton in the Museum of the University of Cambridge.

† Owen, *ut supra*, Plate xix.

‡ Plate xviii. Figs. 71-74.

vidual variation, but generally projecting outwards and backwards. Behind this, the edge of the bone curves gradually inwards, until near the posterior extremity, when it curves outwards again. There is a short blunt process on either side of the extremity of the posterior edge, and a more or less deep notch in the centre, between the two ridges that mark the origin of the keel. Between these processes and the central notch the edge curves outwards. The form of these parts will be best understood from the figures of a male and a female sternum, here given, Plates xlviii., xlix., figs. 1, 2. Individual variations, probably depending to some extent on age and sex, seem to be very great, and the median notch is in some specimens wholly absent. The costal border is, moreover, perfect in a sufficient number of specimens to place beyond all doubt or question the existence of *four* articular surfaces only.*

Scapular Arch.

The present collection, made by Mr. Jenner, contains three complete furculæ (Plate xlvii. fig. 3, Plate, l. fig. 7) and the fragments of three others. We are thus enabled to decide that this bone is most thoroughly Columbine in form. We have nothing to add to the description before given of the scapula, coracoid, and the bones of the wing, for unfortunately no phalanges have yet been found.

Bones of the Leg.

The femur, tibia, and metatarsal have been already so fully described by Dr. Melville, Mr. Strickland, and Messrs. Newton, that we need not enter upon that part of the subject in this place. As, however, it is on the difference of size in these bones that especial stress has been laid by Strickland, and more lately by Professor Owen,† in their attempt to prove that there were two species of Solitaire, which they designate respectively *Pezophaps solitaria*, and *P. minor*, we have carefully measured a very considerable number of specimens, as will be seen by the following table:—

——	Femur.		Tibia.		Metatarse.	
	R.	L.	R.	L.	R.	L.
Presumed Males -	41	28	42	41	36	34
Presumed Females -	31	38	40	42	29	33

* Compare Newton, p. 338, with Owen, Trans. Zool. Soc. vii., p. 514.

† P.S.—Aug. 1878.—Still more recently (Ann. and Mag. Nat. Hist., January 1878), Professor Owen has tacitly admitted the error he had espoused.

In this number of bones we have before us the remains of at least 42 specimens of each sex.

The dimensions of these are as follows, in inches :—

——	Femur.		Tibia.		Metatarse.	
	Largest.	Smallest.	Largest.	Smallest.	Largest.	Smallest.
Presumed Males -	7·28	6·60	10·90	10·20	7·45	6·80
Presumed Females -	6·10	5·55	9·30	8·35	6·14	5·40

——	Femur.	Tibia.	Metatarse.
Difference in length between largest and smallest presumed male.	·68	·70	·65
Difference in length between largest and smallest presumed female.	·55	·95	·74
Difference in length between smallest male and largest female	·50	·90	·66

From this it will be seen that though the differences in length between the largest and smallest of each supposed sex are generally greater than the difference between the smallest male and the largest female, and though there are bones of length intermediate between the largest and smallest of one sex, there are no bones of a length intermediate between the smallest male and the largest female, as would doubtless have been the case had there been more than one species on the island.

The present collection contains twenty-eight ungual phalanges which agree in character with the three figures referred to above, but we consider that it is almost if not quite impossible to determine their exact position on the foot. We believe, however, that the present collection contains those phalanges which were noted in the former paper as wanting, and we have accordingly reconstructed the foot of *Pezophaps* (Plate i., fig. 7) after Strickland's figure of that of *Didus*.*

Skull.

Of the cranial portion of the skull, the collection includes seventeen specimens, together with fragments of eight others. Moreover, we had nine submitted to us by the authorities of the British Museum. Of the twenty-six specimens that are more or less complete, twelve may be assigned to females, and nine to males.

In all these, the depression of the central tract noticed in the former Memoir

* We have come to the conclusion that some of the ungual phalanges formerly figured (Plate xx., Figs. 113, 114, 125, 127) were incorrectly referred to *Pezophaps*. They belong to some species of *Chelonia*. On that plate, Figs. 108, 109, and 115, alone refer to *Pezophaps*.

(p. 246), is most marked, subject, of course, to individual variations, being in some quite flat, in others slightly concave, or divided into two portions by a low transverse tumescence. The occipital and frontal ridges are well marked in all; but the degree of their elevation, especially in the case of the former, varies with age and sex; being occasionally raised into warty protuberances separated by deep depressions: and the severance of the occipital from the ex-occipital portion is always observed. The frontal ridge, or boundary of the central tract, is less elevated than the occipital. It is always divided into a more or less distinct central portion, forming the forehead of the bird (Plate l., fig. 1, *a*.), and two lateral protuberances marked by more or less prominent exostoses (Ibid., *b*.), directed forwards and inwards, and in some cases even meeting in the median line. In old specimens, the maseteric ridge always exists as an elevated line, forming the lateral boundary of the central tract behind the orbits. This ridge is well shown in the specimen figured in the former Memoir (Plate xxi., fig. 142, Plate xxii., fig. 149).

On making a vertical and longitudinal section of the skull of the Solitaire, the extent of cancellous structure disposed between the external and internal walls of the cranium is seen to be of considerable extent, but developed very differently from the same tissue in *Didus;* as is seen by looking at the figures of Prof. Owen (Plate xxiii., figs. 1, 5). The enormous lofty and rounded elevation of the skull between the orbits is there seen to be due to a mass of pneumatic diploë exceeding "the longitudinal "diameter of the cavity containing the cerebral hemispheres." This is wholly wanting in *Pezophaps.* We find the cancellous structure to be thinnest precisely where it is thickest in *Didus,* namely, immediately above the centre of the cerebrum (Plate l., fig. 2 *a*); while in front, the forehead consists of a mass of the same extending between the orbits, and round the nasal passages (Ibid., *b*.). Professor Owen, who had already noticed the flatness of the frontals between the orbits in *Pezophaps* (Trans. Zool. Soc., Vol. vii. p. 517), thus wrote of this part of the skull in 1871:—
"I suspect that when the part of the skull of the Solitaire may be found, supplying "what is wanting in the specimens figured in figs. 149, 150, pl. 22 (N.), there will "be a depression or concavity in the profile contour between the fore part of the "frontals, and the naso-premaxillaries, which will suggest the presence of a 'frontal "'protuberance,' differing only in degree from that so called in *Didus.*"

The present series of specimens, while revealing (as the study of a long series alone can do with certainty) the normal form of the forehead, of which the section shows the internal extent, do not in reality add anything to our knowledge of the essential information of that part, which Professor Owen might have found delineated in the very figure (Plate xxii., fig. 149), to which he has made reference above. Not only is there no depression or concavity as anticipated by him, but the anterior aspect of the conjoined frontals slopes gradually forwards, without

either elevation or depression. It was, no doubt, to this that the frontlet was attached in the female birds, of which Leguat says :—"Elles ont une espèce de "bandeau comme un bandeau de veuves au haut du bec qui est de couleur tanée."

If the sections of the two crania be placed side by side, so that the basi-cranial axis may be horizontal, it will be seen that in *Pezophaps* the base of the brain lies in the main parallel to it, while in *Didus* it is thrown so far backwards and upwards that it makes a considerable angle with it, as in the Common Pigeon.

The cancellous structure varies considerably in different parts of the cranium. On the upper surface, and above the frontals, it is of close, firm texture, consisting of small sub-equal and sub-spherical cells; but above and below the nasal passages, and in the body of the basi-sphenoid, the cells become larger, and the bone more light and spongy. The united naso-maxillaries form a solid mass of bone, contrasting with the porous structure of this part in *Didus:* while a section of the beak shows one long elliptical cell (Plate l., fig. 2, *c.*), surrounded by smaller ones of similar shape. The maxillary branch of the premaxillary, on the contrary, the peculiar structure of which was dwelt upon in the former memoir (p. 347), commences as a solid bone, which, as it widens, is lightened by the expansion of large cells within its mass, the walls of which are pierced by smaller openings, and the whole included within extremely thin outer walls of bone.

In the former paper, it was stated of the maxilla :—"There is a remarkable "variation in the size of the upper mandible in different individuals to the extent "of very nearly one-half the linear dimensions between the largest and smallest "specimens, of which the collection contains thirteen in all, some of which, how-"ever, are merely fragmentary, and the best exceedingly imperfect."

This passage was cited by Prof. Owen (Trans. Soc. Zool. VII., p. 517), with the question appended, "Is there an intermediate gradational series? May this difference "of length of beak concur with that pointed out by Strickland in length of leg?"

The present collection, which includes fifteen perfect specimens, enables us to answer this question in the affirmative. The following tables of admeasurements, taken along the lines *a—b*, *c—d*, (Plate l. fig. 5) show that while the difference in size between the largest and the smallest beaks is not so remarkable as that observable in the legs, yet it is entirely of the same character and as fully dependent on sex :—

—	Presumed Adult Males.					Presumed Adult Females.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Length (in inches) - -	3·40	3·40	3·36	3·35	3·33	3·10	3·07	3·07	3·06	3·05	3·05	3·00	2·95	2·88	2·87
Height (in inches) - -	·95	·92	·91	·90	·90	·79	·81	·76	·78	·80	·80	·75	·70	·74	·70

From the above table we learn that the greatest difference between the skull of the largest and smallest presumed males is in length ·13 of an inch, and in height ·05; that between the largest and smallest presumed females is in length ·23, in height ·11; and that between the smallest presumed male and the largest presumed female is in length ·23, and in height ·11.

The variation in the size of the skull is not so marked, and the 19 specimens which could be fairly measured shewed the following result:—

—	Presumed Adult Males.							Presumed Adult Females.										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
Length from forehead to base of occiput.	3·36	3·36	3·36	3·35	3·33	3·33	3·30	3·13	3·08	3·07	3·05	3·04	3·02	3·00	3·00	2·96	2·95	2·95	2·92
Extreme breadth of skull.	2·80	2·72	broken	2·76	2·80	2·71	2·69	broken	2·37	broken	broken	2·38	2·35	2·40	2·30	broken	broken	2·38	2·39

It will be seen from this table that the greatest difference between the largest and smallest presumed adult male in length of skull is ·06, in breadth ·11; the greatest difference between the largest and smallest females is in length ·21, in breadth ·1; and the greatest difference between the smallest male and the largest female is in length ·17, and in breadth ·11.

There is not only considerable variation in the degree in which the tip of the beak is hooked, as has been already shewn in the former memoir (Plate xxii., figs. 155–157) but the beak is occasionally almost straight. The posterior portion, that which abuts upon the frontals, was in the former collection either absent or imperfect. The present collection includes six specimens which show this part (three males and three females).

The nasals (Plate l. fig. 4, *na.*), and the premaxillaries (Ibid. *pmx*) are of nearly equal width at the point of junction with the cranium; an equality which is preserved for some distance. That portion of the nasals which appears on the superior surface of the beak is never anchylosed to the premaxillaries. There is even occasionally an interval left between them. The premaxillaries also are not only not confluent throughout, even in adult specimens, but for a distance equal to about one-fourth of their entire length from the cranium even include a narrow space between them. In *Didus* a certain resemblance to *Pezophaps* is observable; the premaxillaries being broad and flat, and the nasals free for a short distance (STRICKLAND, Plate ix.); but the proportions are quite different. In *Goura*, on the other hand, each nasal is three times the width of the united premaxillaries.

The palatals, which we are now enabled to describe and figure for the first time (Plate l., figs. 4, 5, 6 *pl*), are complete in four specimens. Their posterior attachments, which abut against the rostrum of the basi-sphenoid (Ibid., fig. 4, *c.*),

are broad and slightly concave, but there is no reason for supposing that they meet in the median line. The hinder border is thin and abruptly truncate. The horizontal plate of the bone bends abruptly outwards, then forwards and inwards to join the maxillary; the inner edge, which is more vertical, is produced at its anterior extremity into a very delicate and sharp point (Ibid. *a*.).

The maxillo-palatals (Ibid., figs. 2, 5 *mxp*) are two elongated processes of a light spongy texture. Their shape is constant in the seven specimens we have examined; but the degree of cancellous structure varies in individuals, and even on the opposite sides of the skull of the same bird. There is usually a deep pit hollowed out at the end nearest the nasal passages and extending right through the substance of the bone to its inner including wall. This is sometimes simple in outline, but more frequently subdivided by thin spicules of bone stretching across it in different directions, so as to subdivide it into numerous small cells.

The jugals, of which there are four specimens, are thin and flat, with a feebly marked process on the superior surface at their proximal end. The squamous suture, by which they are joined to the maxilla, extends for nearly two-thirds of the length of the bone. One of these is figured (Plate xlv., fig. 12).

The lachrymal (Plate l., fig. 3 *la*), forms the anterior, and, to a certain extent, the inferior, edge of the orbit. It is attached above to the prefrontal by a long articular surface distinguishable only in young specimens. It sends out forwards a long pointed process (Ibid. *a*.) varying somewhat in shape in different individuals, which approaches the boundary wall of the nasal passage, but neither unites with it, nor advances sufficiently far forward to join the nasals. Below this the lachrymal sends out backwards a sub-conical recurved process (Ibid. *b*.) spongy in texture. This is met and supported by a thin process developed from the upper part of the rostrum of the basi-sphenoid and forming part of the outer wall of the nasal passage.

The pterygoid, of which the collection contains nine specimens, is a short, stout, pillar of bone, nearly straight. The process by which it articulates with the quadrate, makes nearly a right angle with the plane of the bone and is bounded by a thin expanded surface. At the distal end it abuts against the sphenoid by a level triangular surface of considerable extent, bounded distally by a sharp edge, which meets, without distinct articular facets, the thin hinder edge of the palatals (Plate xlv., figs. 10, 11).

Brain.

We have had a cast made of the brain-cavity, by the help of which we can form a tolerably accurate idea of the size and shape of the brain. It seems to have been rather small in proportion to the size of the bird; but comparison with that of a tame Pigeon (*Columbia livia* var. *domestica*) shews that it closely resembles it in

general shape, and especially in the great breadth of the central lobes. It is figured of the natural size (Plate xlv. fig. 14).

Stone swallowed by the Solitaire.

In his description of the hen Solitaire, LEGUAT says :—

"On leur trouve toujours dans le gésier (aussi bien qu'aux mâles) une pierre brune de la grosseur d'un œuf de poule; elle est un peu raboteuse, platte d'un côté et arrondie de l'autre, fort pesante, et fort dure. Nous avons jugé que cette pierre naît avec eux; parce que quelque jeunes qu'ils soient, ils en ont toujours, et n'en ont jamais qu'une; et qu'outre cela, le canal qui va du jabot au gésier, est trop étroit de moitié pour donner passage à une pareille masse. Nous nous en servions préférablement à aucune autre pierre, pour aiguiser nos couteaux." *

The attention of Mr. H. H. Slater was specially drawn to this statement before he went to Rodriguez; but notwithstanding his careful examination of the caves of that island, he was unsuccessful in finding anything bearing out Leguat's statement. Shortly after his return, Mr. Caldwell, of Mauritius, Corresponding Member of the Zoological Society of London, visited Rodriguez.† He was more fortunate, and obtained three of what he believes to be the stones mentioned by Leguat, which he describes as follows :—

"Of the three stones found *in situ* A and B were taken by Sergeant Morris [of the Police], in my presence, and C, the stone I have given you, by myself; but all in my presence.

"The first found was B. Morris had called me to see the leg bones protruding from the dry powdery soil in the upper or entrance chamber of the cavern, and we began carefully to remove the earth. We then came to the sternum (which was in every case keel above), when Morris put his fingers under it to lift it entire, and said 'there is a round stone under it.' The earth was then more carefully removed, the sternum lifted, and the stone close up to it. No other stone was found until we reached the floor about 20 inches below the surface, but even the fragments occasionally found in no way resembled this, or the other two subsequently found, being coralline. We did not at first pay much attention to the stone; I had merely put it in my pocket, being puzzled to account for a rounded basalt pebble being found in the dry earthy dust of a cavern in the face of a low cliff above the large main cavern we had explored in vain. It should be noted that in this chamber there was plenty of light.

"Stone A was found in the lower chamber of the cavern by Morris. When he called to me that there appeared to be an entire bird embedded, I came up. There was a very bright lamp with us and each bone was carefully uncovered and put aside. Here again the bird was on its back buried in the loose dusty soil, and the sternum consequently uppermost. It was very carefully raised by Morris, when stone A was found in exactly a similar position to the last. It was then Morris remarked 'it would be curious if this were the stone the bird was said to have in its belly.'

* Voyages et Avantures de François Leguat, &c. Londres: MDCCVIII., vol. i. p. 100.

† Proc. Zool. Soc. Lond., 1875, pp. 644–647.

"The third stone was found in the upper chamber by me, and also under the fragment of the sternum which accompanies the stone, but the bird was very incomplete, and apparently young.

"J. CALDWELL, 6 Dec. 1877.

"P.S.—There are no stones of similar composition to these in the neighbourhood of any of the caverns where Solitaire bones have been found. I should think the nearest place where fragments of basalt could be found would be at least two if not three miles from the cavern where I found them."

One of these stones he was so good as to give to Mr. Edward Newton. It is here figured in three aspects (Plate xlvii. figs. 4, 5, 6). It weighed, before it was cut for the purpose of determining its mineralogical nature, a little over $1\frac{3}{4}$ oz. It is brown, somewhat rough, heavy, and hard. It is hardly, however, to be called "flat on one side," as Leguat describes those he had the opportunity of observing. In connexion with this fact, however, it may be remarked that the bird with whose remains it was associated appears to have been young.*

We have to thank Professor Bonney, M.A., F.R.S., for the following report on the microscopic structure and mineralogical composition of the stone :—

"This rock externally presents considerable resemblance to a dolerite. Such it is proved to be on microscopic examination; the slide shewing a crystalline mixture of plagioclase felspar, augite, olivine, and a peroxide of iron (? hematite). The plagioclase is well preserved; the sections are commonly about six times as long as wide, and exhibit the characteristic twinning; probably it is labradorite. Enclosures of opacite, augite (?), and other microliths, with minute gas-cavities, are frequent in some crystals, rare in others; colours with polarizing apparatus fairly bright. The augite in the sections is of a pale puce-brown colour, rather rough in texture, and with the nicols fairly rich coloured. The olivine also shews brilliant colours; with ordinary light it is nearly colourless, except where stained a warm brown through incipient decomposition; some crystals are thus rendered almost opaque. For this reason, and the absence of serpentine, I conclude this to be a ferriferous variety approaching hyalosiderite. The grains of iron peroxide are not very numerous and are rather irregular in form. It seems most probable that they are hematite. These minerals are enumerated in order of frequency. The felspar, as is not unfrequent in doleritic rocks, is pierced in places by long acicular microliths, nearly colourless; some of which may possibly be apatite."

* P.S., August 1878.—The stone was exhibited to the Zoological Society, 5th March 1878, by Professor Newton. The preceding description is borrowed from the remarks made by him on that occasion. (Proc. Zool. Soc. Lond., 1878, p. 291.)

Concluding Observations.

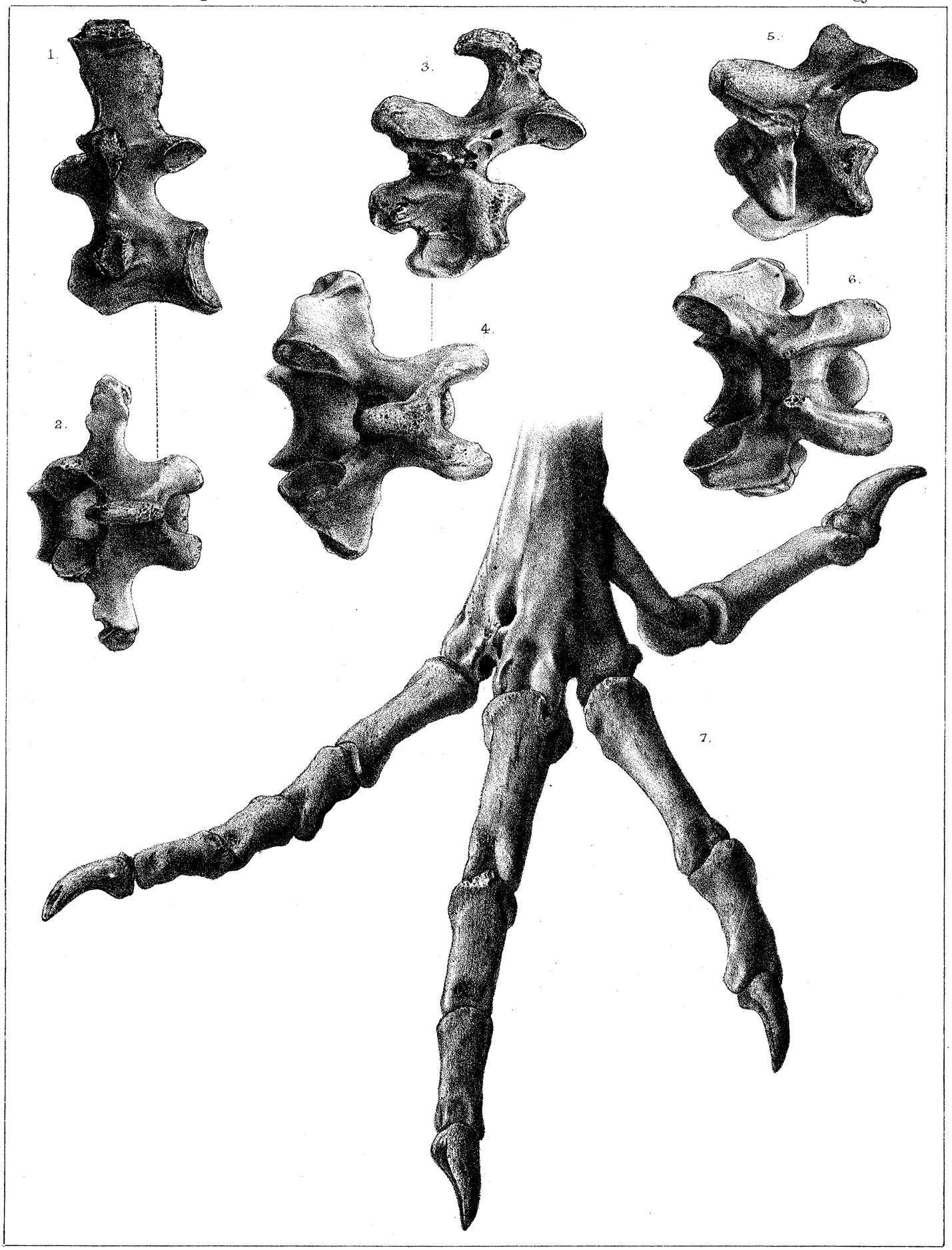
The minute examination of the enormous series of specimens at our disposal enables us confidently to affirm the "bold" statement made in the former Memoir (p. 330):

"There does not seem to be a single bone in the skeleton of *Pezophaps solitaria* which is not liable to greater or less individual variation of some kind or other; . . . . . the individual variation is not at all confined to absolute size; it extends to the relative proportion of divers parts of the bone, to processes or depressions upon them such as are commonly held to be specifically characteristic, so that it is often utterly impossible to predicate any definite limits of individual modification."

We are not aware that the osteology of any vertebrate, other than man, has been studied with the same wealth of materials as that of the Solitaire. About the wonderful variability of this particular species no doubt can exist. The bearings of this fact on the theory of Evolution will not here be entered into; but that they will of necessity prove to be most important in future discussions of that theory, and of many of the questions arising from it, can hardly fail to be admitted. We have deviated so far from the example set in the former Memoir as in certain cases to give precise measurements of certain bones; but it must especially be borne in mind that variations in length, breadth, and thickness form but a comparatively immaterial portion of the variations which exist. These are often, nay almost always, of a kind which cannot possibly be expressed in words, and could only be represented by a series of figures almost equal in number to the specimens.

The age of these bones has not hitherto been taken into consideration. Some of those found on a former occasion were considered by Professor Steenstrup (Proc. Zool. Soc. 1855, p. 718) to bear traces of having been broken by man, or by some predatory animal, in order to extract the marrow. In the present collection, however, we cannot find any examples of this kind. There is no evidence by which we can determine the age of the bones; and the collection may include the remains of birds which lived at a very remote as well as at a very recent period. It is to this cause that we ought perhaps to ascribe some portion of the wonderful variability observable in the remains of *Pezophaps solitaria*.

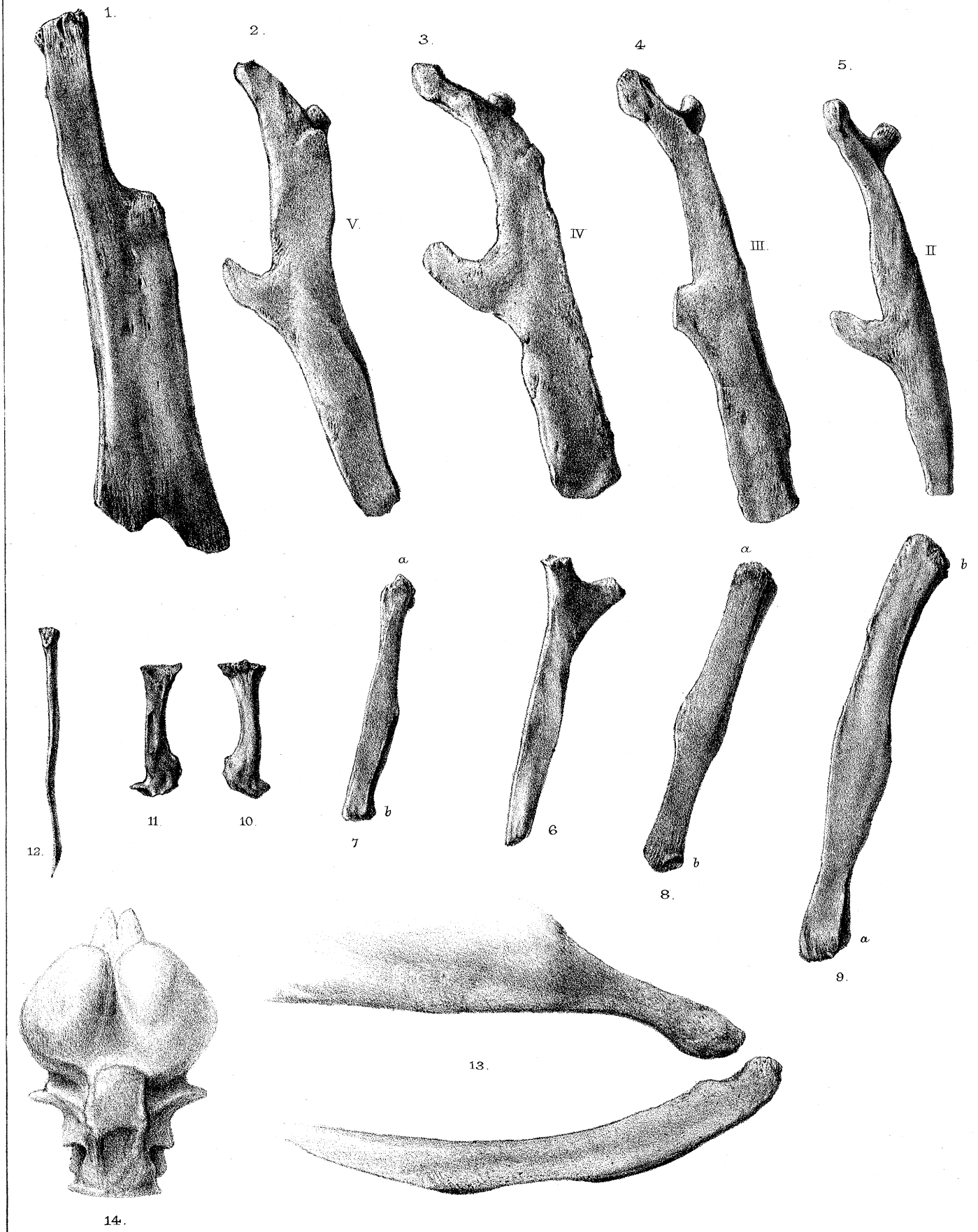
P.S., August 1878.—In his recently published paper (Ann. and Mag. Nat. Hist., January 1878, p. 87), Prof. Owen remarks of the præsacral vertebræ of *Pezophaps*:—"So much of the vertebral formula thus accords with that of *Didunculus*." This is a tribute to the fidelity with which the late Mr. JAMES FLOWER obeyed the directions of Professor FLOWER, which were that the skeleton of *Pezophaps*, at first deposited and mounted at the Royal College of Surgeons, and subsequently transferred to the British Museum, where it was examined by Professor OWEN, should be articulated in accordance with the skeleton of *Didunculus*, in which of course the number of vertebræ is known.



R. Mintern del. Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

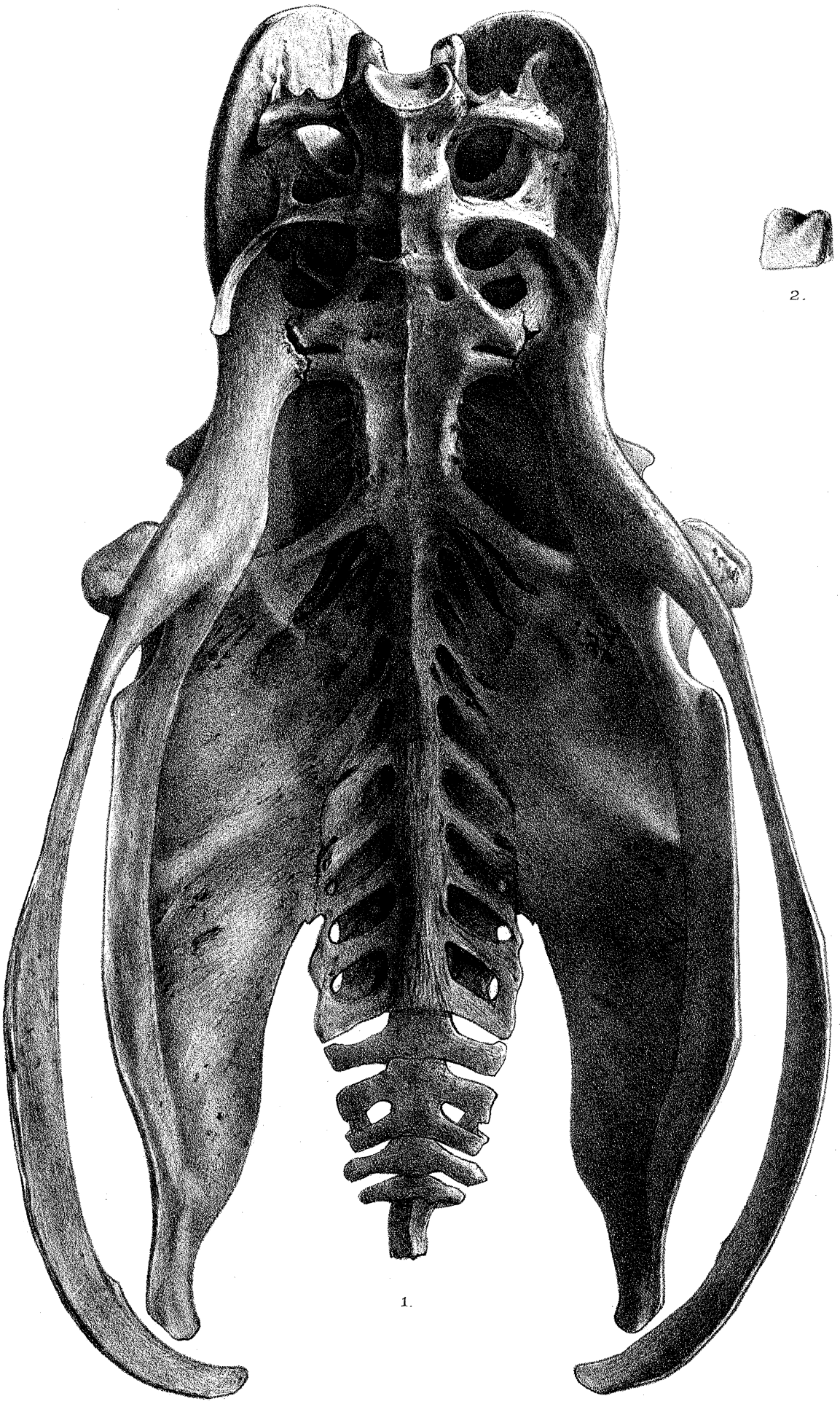
1 — 2. *Eighteenth Vertebra.*
3 — 4. *Thirteenth Vertebra.*
5 — 6. *Twelfth Vertebra.*
7. *Left Foot.*



R. Mintern del. Mintern Bro^s lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

1. *Sixth and seventh sternal ribs.*
2–6. *Vertebral ribs of right side, ♀*
7–9. *Sternal ribs, ♀*
10, 11. *Pterygoids.*
12. *Jugal*
13. *Extremity of ischium and pubes.*
14. *Brain.*



2.

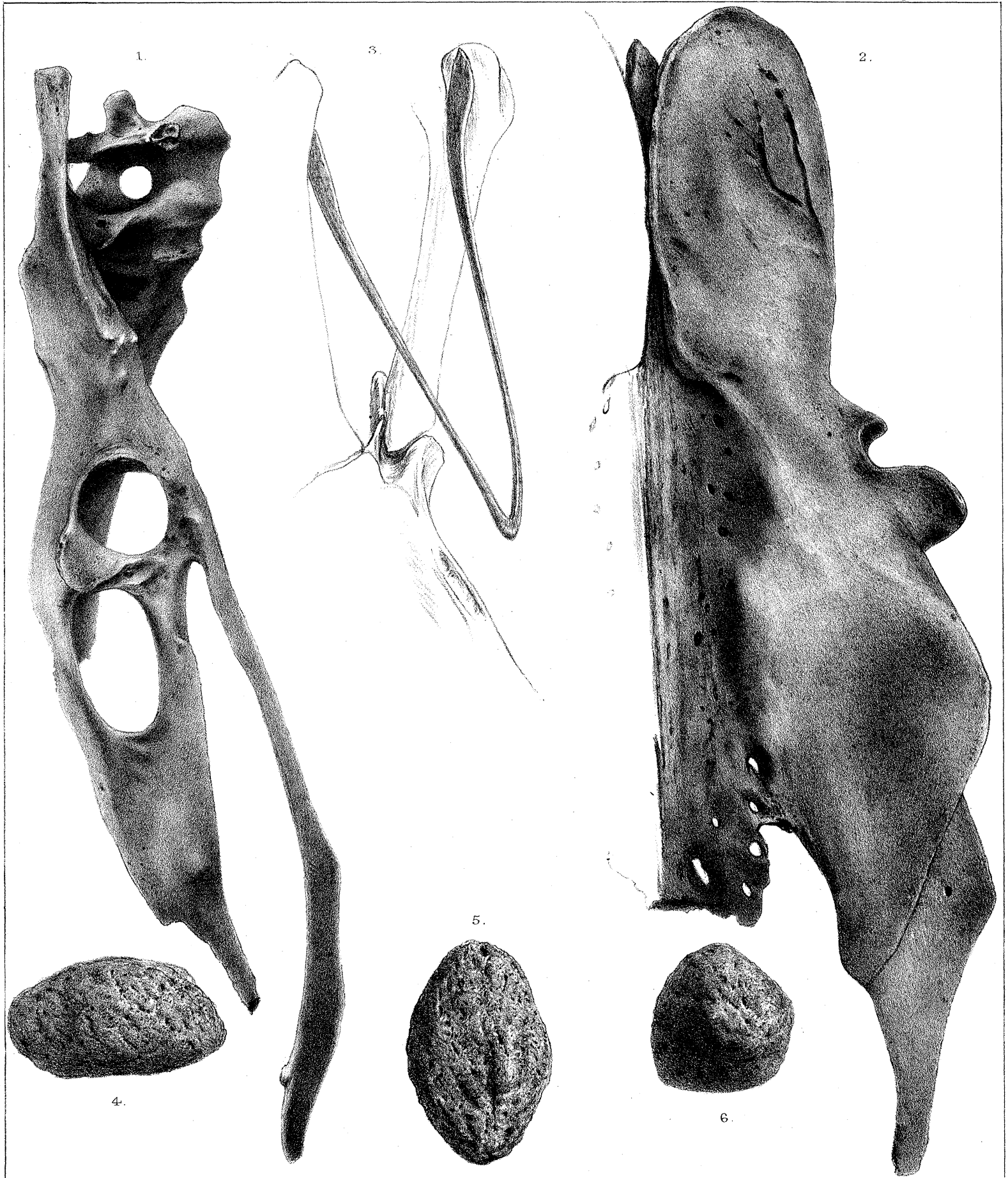
1.

R. Mintern del.

Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

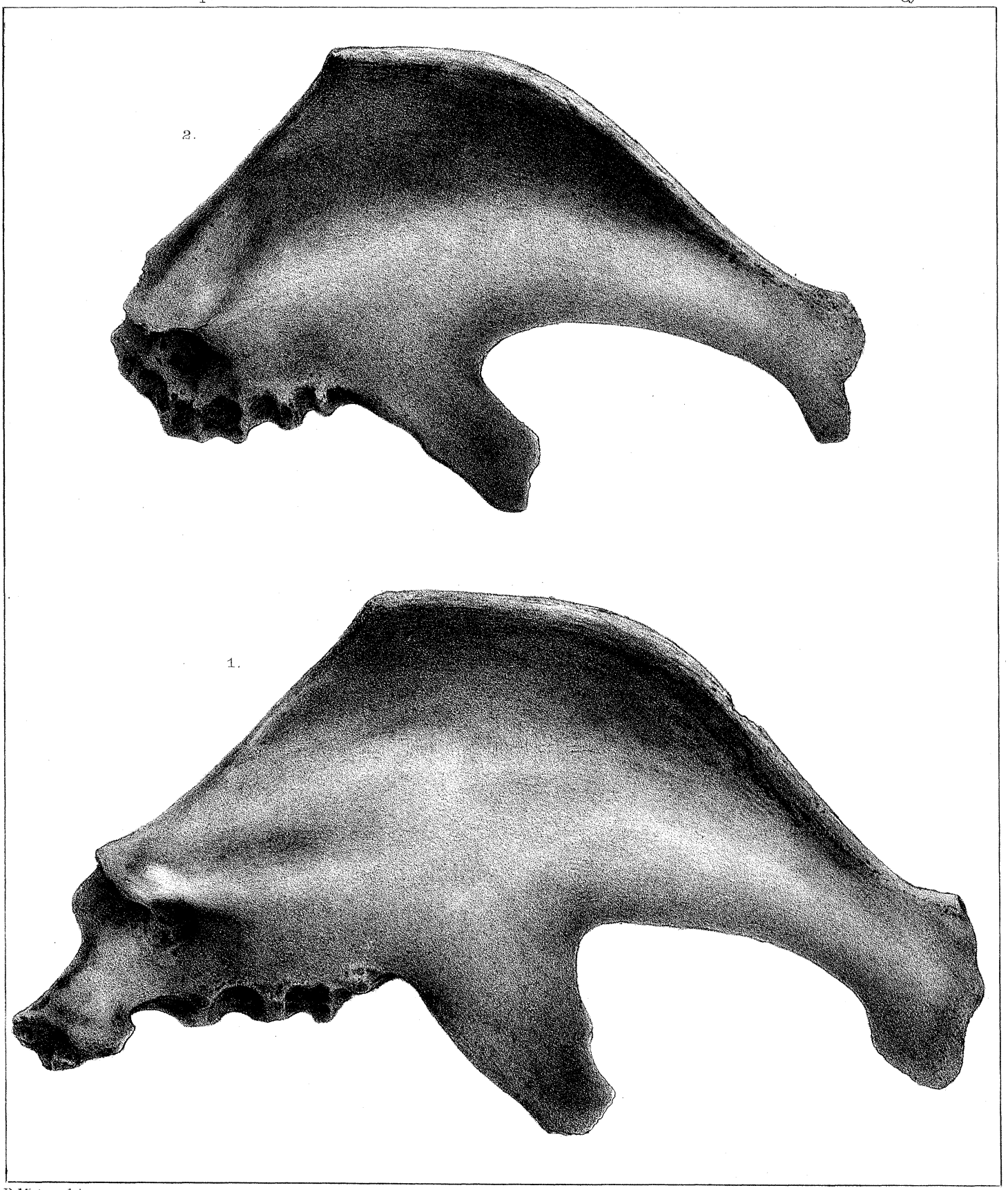
1. Pelvis of male skeleton. *2. Side view of coccyx.*



R. Mintern del. Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

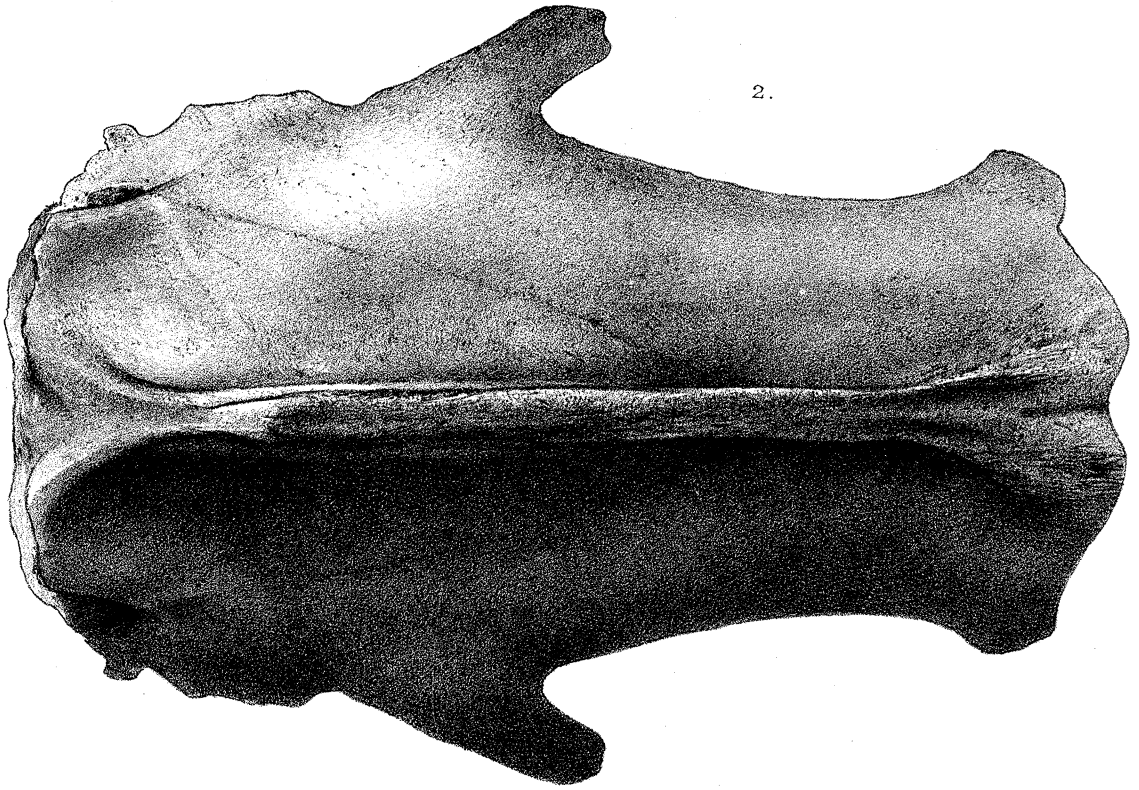
1. *Pelvis* ♀
2. *Pelvis* ♂
3. *Furcula.*
4. *Stone swallowed by the Solitaire.*

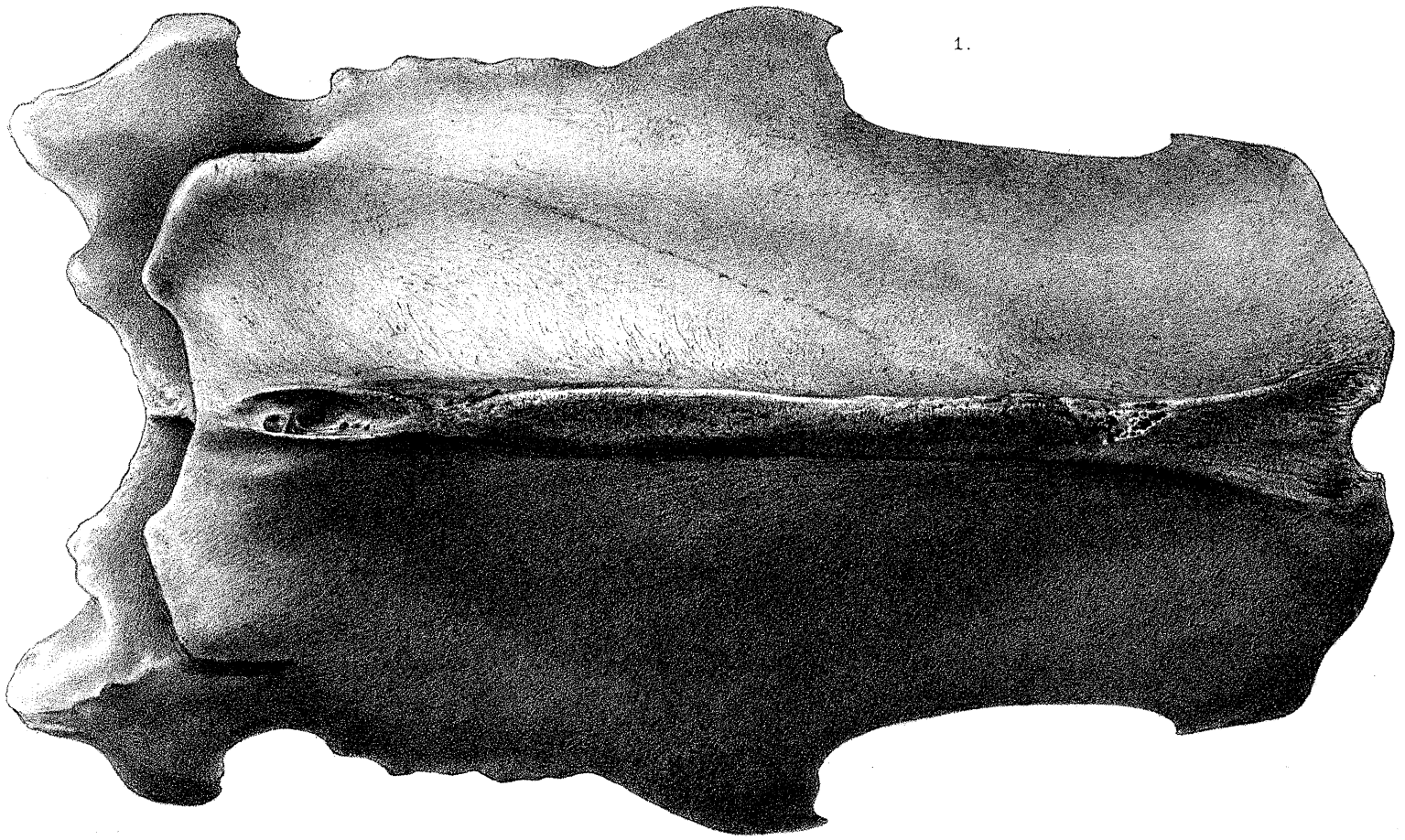


R. Mintern del. Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

1. *Sternum* ♂. 2. *Sternum* ♀

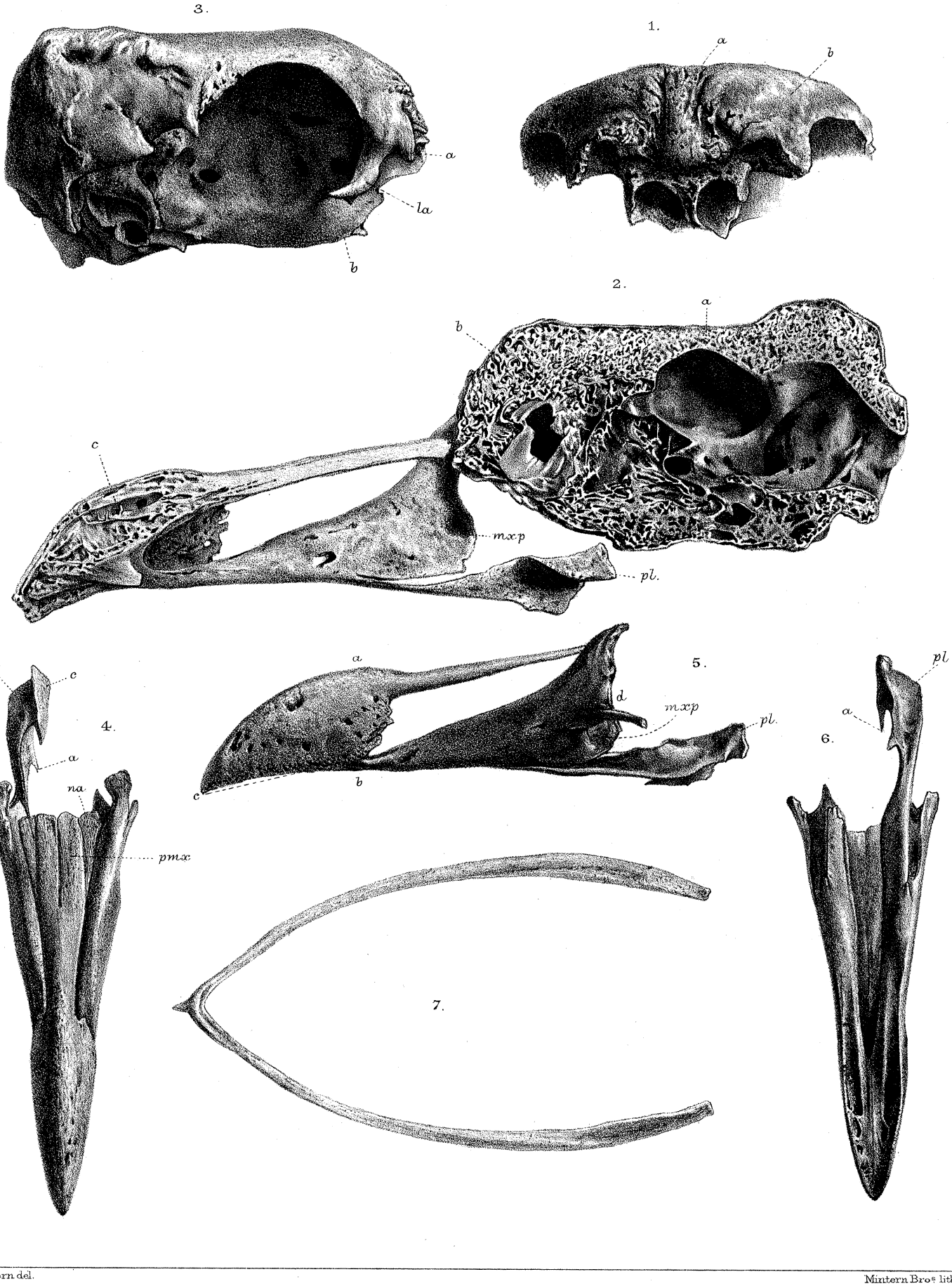




R. Mintern del. Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

1. *Sternum*, ♂ 2. *Sternum* ♀



R. Mintern del.

Mintern Bros lith.

SOLITAIRE. — PEZOPHAPS SOLITARIA.

1 – 6. *Portions of Skull.* 7. *Furcula.*